

(PEO)<sub>10</sub>LiCF<sub>3</sub>SO<sub>3</sub> Composite Electrolytes with  
Micro-Sized Titanium Oxide Powder  
Prepared by Ball Milling

K. W. Kim , J. H. Shin, H. J. Ahn and J. H. Ahn  
Advanced Materials Research Institute,  
Gyeongsang National University, Chinju, Korea

Linear poly(ethylene oxide) has been studied for electrolytes in thin-film high energy density batteries because of its coordination with alkali metal ion. Weston and Steele have investigated the not only mechanical stability of electrolyte also the effect of the ceramic filler on the ionic conductivity and transference number using the  $\alpha$ -alumina powder,[1] and recently Croce et al have demonstrated that new types of nanocomposite polymer electrolytes have a very stable lithium electrode interface and an enhanced conductivity at low temperature, both properties combined with good mechanical properties.[2] We investigated the electrochemical characteristics and conductivity of (PEO)<sub>10</sub>LiCF<sub>3</sub>SO<sub>3</sub> composite electrolytes with micrometer titanium oxide powder. In addition, we present discharge capacity and initial cycle performance of Li/S cells at elevated temperature.

Titanium oxide powder was prepared by ball milling using the pure sponge titanium(99%) bulk. A ball-to-powder ratio of 20:1 has been employed using hardened stainless steel balls with diameter of 7.5mm. The a.c. impedance measurements were performed with an amplitude of 10mV over a frequency range of 10<sup>5</sup>Hz to 1Hz at ten points per frequency decade. Arrhenius plot was performed with SS/electrolyte/SS cell configuration over the temperature range 20 to 100°C. The area and thickness of 50% sulfur electrodes used for capacity and cycling were approximately 0.8cm<sup>2</sup> and 80  $\mu$ m, and the weight of sulfur electrode was only 2.2mg.

Titanium oxide consisted of mainly spherical shape of submicron size and around 2~ 3  $\mu$ m and have various phases such as Ti<sub>2</sub>O<sub>3</sub>, TiO and Ti<sub>2</sub>O. The ionic conductivity of composite electrolyte with titanium oxide increased by an order of magnitude compared with polymer electrolyte without titanium oxide as shown in Fig. 1. As shown in Fig. 2, (PEO)<sub>10</sub>LiCF<sub>3</sub>SO<sub>3</sub>-Ti<sub>n</sub>O<sub>2n-1</sub>(n=1,2) composite electrolyte with higher amount of titanium oxide can increase ionic conductivity at low temperature. In all cells, discharge capacity increased according to increasing amount of titanium oxide. A first discharge showed the highest sulfur utilization for all cells, and sulfur utilization during cycle test was gradually decreased to tenth cycle after the first discharge. The higher amount of titanium oxide exhibited a good interfacial stability and optimum content was 15wt%. The details will be discussed in the Meeting.

REFERENCES

1. J. E. Weston and B. C. H. Steel, Solid State Ionics, 7 (1982) 75  
2. F. Croce, L. Persi, F. Ronci and B. Scrosati, Solid State Ionics, 135 (2000) 47

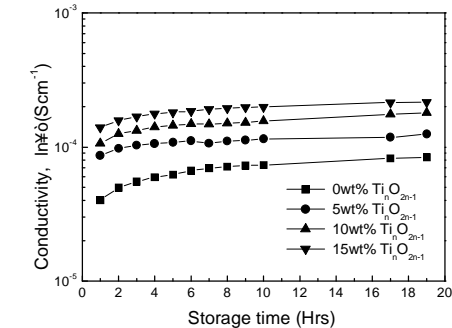
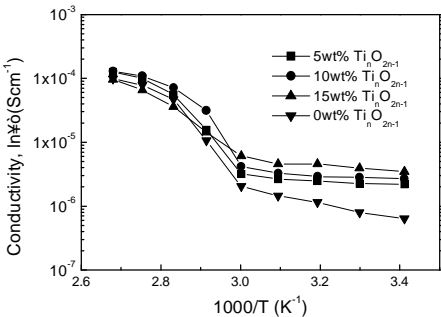


Figure 1. Ionic conductivity as function of storage time at 90°C for composite electrolyte with titanium oxide.

Figure 2. Arrhenius plots of the conductivity for composite electrolyte with titanium oxide.

Figure 3. The changes of sulfur utilization with the number of cycle for Li/electrolyte/50% Sulfur cells



with charge/discharge of 100mA/g Sulfur at 90°C for (PEO)<sub>10</sub>LiCF<sub>3</sub>SO<sub>3</sub>-Ti<sub>n</sub>O<sub>2n-1</sub> composite electrolyte.

